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OPERATIONAL ASPECTS OF CONTROLLED ACCESS FACILITIES[a]

Joseph E. Havenner,[1] A.M. ASCE

SYNOPSIS

The operational aspects of extensive mileage of controlled access highways demand new concepts and techniques in the fields of highway administration, organization, design, construction and operation. Moreover, close coordination between planners, motor vehicles manufacturers, enforcement officials and engineers is essential.

One of history's engineering wonders of the world is unfolding across the forty-eight states in the form of the Interstate System of National and Defense Highways and the related urban connections and extensions. In today's automative age we are inclined to take for granted the facilities which make possible the social and economic structure of our nation based upon a car or two in every garage. But in some distant age archeologists of the day will no doubt discover with amazement the staggering magnitude of more than 40,000 miles of controlled access highways, the urban connections and extensions, and the untold thousands of structures comprising the system. But the criteria which must be met if we are indeed to label the Interstate Highways a contemporary engineering wonder of the world will have mostly to do with the dynamics of the system. How efficiently will it transport persons and goods, swiftly and safely, in the Nation's conduct of the most active economy the world has ever known.

Factors which will determine how well the system operates are many and complex. They involve highway and community planning, highway and structural design and construction, motor vehicle design and operation, motor vehicle legislation, and operating services including enforcement.

One can hardly compare the systems engineering involved with the

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a. Presented at the October 1958 ASCE Convention in New York, N. Y.

1. Pres., Inst. of Traffic Engrs. and Director, Eng. and Technical Services, Auto Club of Southern California, Los Angeles, Calif.

engineering of a dam, for example, and the related hydraulics system, where the engineering agency has control of all elements of the system and can integrate their inter-relationships to achieve objectives involved in the basic concept of the structure. The completion of the Interstate system of highways will cut across a fair share of every social, economic, and political segment of our national community. It requires the coordination of many divided and sometimes overlapping jurisdictions of both government and private enterprise. It involves many different professional disciplines.

The application of the controlled access principle in the construction of a highway through a community has such an impact that forces are immediately at play which complicate the planning, design, and engineering of the facility. In urban areas, perhaps 35 acres per mile of private property must be acquired. Access of remaining abutting property is denied. Existing street patterns are interrupted and locations of access must be located sparingly. Every affected property owner, every business enterprise, every institution along the right of way exerts pressure in one form or another which affects final design.

If the engineering agency has been successful in acquiring sufficient land in the proper location with the proper connections to the surface street system techniques of geometric and structural design may then, if appropriately applied, provide a facility with the potential of safe and efficient operation.

If geometric and structual design has adequately provided for the characteristics of the anticipated traffic stream and the related requirements for direction, emergencies, and services, the operating agency may then apply signing, controls, and appropriate patrols essential to safe and efficient operation.

If the operational features have been adequately provided, the motoring public, with sutiable education and enforcement, will use the facility at adequate levels of safety and efficiency.

In those portions of the country where substantial mileage of controlled access facilities are and have been in operation empirical knowledge is being acquired of tremendous value to those agencies responsible for the completion and operation of the remainder of the system. In recognition of the desirability of compilation of this information and improved communications between the many agencies and professions involved, the Institute of Traffic Engineers is sponsoring a series of Seminars on Freeway Operations. Seminars have thus far been held in Columbus, Ohio; Sacramento, California; Northampton, Massachusetts; and Harrisburg, Pennsylvania. It is planned to hold similar meetings next year in Oregon, Southern California, Texas, Missouri, Illinois and in the south. In the conduct of the Seminars the Institute has had the financial support of a grant from the Automotive Safety Foundation, and the contributed services of specialists from the Bureau of Public Roads, the American Automobile Association, and several of the cities, states, and turnpike authorities, with experience with freeways. The attitude and reaction of the participants as indicated by keen interest and eagerness to absorb information has substantiated the original concept that the operational aspects of controlled access facilities are of basic importance to those agencies facing the responsibility.

It is not intended that this paper be a compilation of findings from the several seminars thus far completed but rather it can be considered to be the conclusions of an observer and participant.

While brief mention has been made of the sequence of engineering and

operational events in the development of a controlled access highway it is not necessarily logical to develop a discussion of the operational aspects in the same sequence. Since emphasis here is upon the operational aspects it would seem appropriate, however, to begin with a discussion of traffic characteristics.

A general statement appropriate to all factors of controlled access design and operations is particularly true of the significant characteristics of traffic. The permissible margin of error of estimation, prediction, and design is much less than on conventional highway facilities. Or stated another way—the effect of error is more damaging to operational efficiency. Or another correlation—there is greater justification for study, research, and investment in the proper determination of traffic characteristics and other determining factors.

The design speed of controlled access facilities for the purpose of determining sight distances and curvature are, of course, customarily elevated beyond the levels of conventional highway design speed. But the problem of selecting the proper specification in this regard is not particularly complicated other than the selection might be affected by problems of location and terrain.

Of greater significance is the factor of operational speed. On rural and unrestricted portions of the Interstate System we can expect a natural tendency on the part of a significant portion of the traffic stream to drive at speeds approaching the design speed. Unrestricted conditions of a controlled access facility not only invite and encourage high speed, but continued driving without the necessity of appreciable slowing or stopping deadens driver sense of speed, and as fatigue may become a factor, other senses are dulled which normally would clue the driver as to impending skids, loss of control, and other hazards.*

As extended mileage of the Interstate system is completed we may expect to see an exaggerated effect of uninterrupted driving at sustained speeds. How motorists will adjust themselves to the opportunity to travel transcontinentally without traffic interruption remains to be seen.

As passenger car speeds increase we can expect an increase in the frequency of extreme speed differentials between vehicles traveling in the same direction resulting from an increase in the number of highway freight units, passenger cars with trailers, and other slow moving vehicles. While highway design will carefully remove bridge abutments and similar fixed objects from proximity to the traveled way the continued differential of performance ability between heavy and light vehicles, particularly on grades, will place the equivalent of fixed objects in the path of fast moving passenger vehicles in the traveled lanes. There is little difference between the effect of a passenger vehicle hitting a bridge abutment at 45 miles per hour and a passenger car moving at 70 miles per hour striking the rear of a truck traveling at 25 miles per hour. This problem is already of concern on many of our completed controlled access facilities. Certainly an objective for early accomplishment will be to minimize speed differentials of this type by control of gradient, by provision of ample passing lanes, perhaps by provision of better performance ability of heavy vehicles, and by the continued and re-emphasized need for placing effective limitations upon the excessive speed of passenger vehicles.

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* Psychology of Trip Geography: Haber, Brenner and Hulbert, Highway Research Bulletin 91.

Operational speed becomes a much more significant factor on urban freeways. Under conditions of heavy traffic density operational speeds on an urban freeway will fluctuate over a wide range.

On such freeways as the Hollywood in Los Angeles unique speed characteristics may be observed. On that particular facility average daily traffic volumes approximate 200,000 vehicles in eight lanes—with more than 8800 in four lanes during the peak hour—or an average of more than 1000 vehicles per lane per hour for twenty-four hours. Even under these conditions traffic seems to move in clusters or waves, with extremely short headways at relatively high speeds. Headways of less than one second at 55 and 60 miles per hour are not uncommon. Under these conditions a disturbance of the traffic stream, even seemingly slight at the time, can result in a tieup or blockade. Los Angeles Police say that a vehicle stopped for 1 minute in a moving lane will tie up all lanes for 10 minutes. The condition can be likened to a chemical solution that is at the point of saturation when the slightest disturbance to the solution will result in solidification or other marked change.

In Los Angeles, at least, it would seem that the driver concept of normal freeway operation would permit him to travel at unrestricted speed at any time. The concept of reducing operational speed to assure continued delivery of dense volumes without interruption and with consequently higher average speeds from point to point seems to be vague and unrealistic, at least to the driver. And yet, at least your speaker, holds firmly to the belief, that the optimum operational speed fluctuates throughout the day, that it can be determined or predicted for any given set of predictable conditions, and that if the information were transmitted through the day to the motorist that the traffic stream would soon come under operational control rather than be left to the vagaries of daily traffic phenomena. To accomplish such control would require the application of some type of electronic detection of changing traffic characteristics and transmitting the resulting operational speed to the motorist via some type of changeable signing. Favorable motorist response could be anticipated, for at present both the too fast and the too slow driver thinks that the other is criminal and neither one really knows what is expected of him in terms of speed at any given time. The result of such a system would be a reduction in the number and duration of delays—a more continuous flow of traffic with a reduction in peak speeds, more uniformity within the traffic stream, and fewer severe accidents.

Of course, the prerequisite to success or even a determination of the suitability of application of such controls, is adequate study and research of traffic characteristics of specific problem areas. Basic research which is bringing our highway capacity information up to date to include the latest advancement in controlled access facilities is being conducted to some extent. Highway Research Board Bulletin 167 contains significant findings of Mr. O. K. Normann and others relating to the relationship of speed and capacity characteristics. Included also is Normann's important desertation on the operation of weaving sections.

Just as the intersectional problem is a basic factor in conventional street capacity, the merge or weave, is basic to the operation of a controlled access facility. On rural sections accident experience appear to cluster about merging sections, on urban sections accidents and congestion appear to be closely related to the merging sections.

Detailed analysis of the merging movement at points of entry and exit and the demands it places upon basic design, geometric design, signing,

maintenance, enforcement, and the motorist will do much to amplify most all of the basic elements of controlled access operations.

The design engineer must consider an adequate prediction of the speed and volumes of the traffic movements involved. He must not only be able to visualize for the individual motorist the appearance of his final design, he must consider how it will look when operating at maximum capacity and other varying traffic conditions.

The design engineer must anticipate the problem of signing and locate sign structures and posts and provide ample areas, clearances, and visibility. Signing to be adequate must be designed by the traffic engineer in step with basic geometric design.

Local jurisdictions with interest in connections to surface streets and highways must not be permitted to make effective demands for frequency or location of connections that will preclude proper spacing of ramps.

The adequacy of signing will have much to do with the successful operation of merging sections. Even in urban areas where the bast majority of the traffic stream will be comprised of daily users, clarity of direction to the strange motorist is of primary importance, for the uncertain actions of a single vehicle can introduce serious frictions to the traffic stream.

The matter of adequate controlled access signing will no doubt be an evolutionary matter. The desirability of uniformity goes without saying. But uniformity in controlled access signing is much more complicated than size, shape, and color. One but has to review the signing of various jurisdictions to be impressed with the wide range of signing concepts. A study currently in progress in California by the Automotive Safety Foundation and the California Division of Highways should provide valuable information on the required basic elements of controlled access signing. Undoubtedly they will substantiate the necessity of the freeway signing to provide the motorist with orientation, advance notice, clear direction, and reassurance, in relation to every point of decision.

On conventional highway systems we have become accustomed to depend upon rather specific rules of the road as provided for in our vehicle codes. It is the enforcement view that rules of the road be as positive and definite as possible so that the matter of violation is easily determined and the application of enforcement is simplified. However, such can hardly be the case in regard to many of the problems of controlled access driving. In a merging section the proper rule for each motorist at an area of conflict changes by the minute. Careful observation of traffic at such locations reveals that proper motorist performance in a constant drama of give and take is essential to a smooth operation. While the basic rule for the entering motorist appears to be to enter the traffic stream at the prevailing speed of the stream to be entered it is not always a simple manuever under conditions of heavy traffic. At one instant entering traffic will yield, but to do so constantly would cause a marked reduction in ramp and main stream capacity. At the next instant entering traffic will rapidly accelerate and the main traffic stream will yield to permit a smooth entry. The probability that a clear and concise rule of the road can be written to cover this situation is remote indeed. It is equally true that present provisions of the uniform code and of the codes of the various states are not applicable to the situation described.

Driver limitations under conditions of controlled access traffic are of even greater importance to the safe and efficient operation of the facilities than has been the case on conventional highways. Consider visual acuity, for example.

About 30% of motorists have 20-20 vision. Traveling at 30 m.p.h. they can read 10 inch letters 13 seconds in advance of the sign. About 65% have 20-40 vision and can only read 10 inch letters 6 1/2 seconds in advance at 30 m.p.h. In California, at least, and I am sure it is true in other parts of the country as well, about 4% have 20-80 vision and only 3 and one-third seconds advance message with 10 inch letters. These figures refer to simple acuity and do not take into consideration the complexities of target value, judgment, and reaction. It is hardly any wonder that some engineers are thinking seriously of a more positive means of transmitting sign messages electronically, rather than by the printed message.

Other factors of reaction time, distance judgment, phychological stability, et cetera, must have as wide a range of performance ability among motorists. In the foreseeable future we will continue to face the necessity of designing highway facilities for motorists the way they are rather than the way we would like them to be. This requires that we have a rather complete knowledge of their limitations and capabilities. Much remains to be done in this field.

At the University of California Institute of Transportation and Traffic Engineering there is a research project in its initial stages that could prove to be of extreme importance. It is proposed that a driver simulator will be constructed that will be capable of simulating highly complex driving situations in the laboratory and studying driver reactions thereto. We are all aware of the use that aviation has made of simulators. Pilots of the new jet transports will have been trained in simulators. We should recognize that there is about the same difference between freeway driving and conventional street and highway driving as there is between jet flying and piston engine flying. Such research as will be possible with a simulator can tell us much about the driver and his relationship to the features of the highway and the vehicle.

A word or two about the motor vehicle. First, and perhaps of most importance. We are planning and building the highways of 1975 or 1980 today. Experience of the past 25 years would indicate that we did a poor job of anticipating changing performance characteristics of the motor vehicle and that this failure accelerated the depreciation of our highway plant. It is doubtful that we can design highways without knowledge of the rolling stock any more than we could design a railroad without knowledge of the type of equipment to be operated. It would appear that improved coordination and communication between the highway engineer and the automotive engineer is called for.

Secondly it is not at all apparent that the motor vehicle of today provides optimum design of instrumentation, cockpit and other features compatible with the limitations of drivers and the demands of modern traffic complexities. Here again accelerated attention to research in this field is needed.

Even the problems of highway maintenance take on exaggerated significance on controlled access facilities. Winter weather maintenance, for example, requires exacting procedures for sanding and snow removal equipment. Even the design of overhead bridge facing comes under scrutiny for the capacity to hold snow which if allowed to accumulate only to fall in the windshield of 60 miles per hour plus traffic will cause serious injuries or fatalities. The California Division of Highways now includes cat walks on its large overhead signs so that maintenance may be performed without interfering with a moving lane of traffic. Every maintenance function must be considered in relation to the moving traffic stream and proper procedures and training of personnel instituted accordingly.

Engineering agencies cannot overlook the problems of enforcement on controlled access highways. As a matter of fact enforcement becomes more of an operating and service function than an activity in pursuit of crime prevention. But features of design relating to access and maneuverability of equipment, for example, are of extreme importance to the enforcement function and must be anticipated in the design stage of construction. Communications along the facility is of extreme importance to both maintenance and enforcement and no doubt will soon become an integral part of the facilities.

The cost of adequate enforcement on controlled access facilities is sobering indeed when one projects the figures into the future. The California Highway Patrol, for example, reports the cost of $32,000 per mile per year for enforcement on urban freeways with the assignment of 2.7 officers per mile for each 100,000 daily volume. With reoccuring costs such as this facing freeway operating agencies the consideration of every savings possible to achieve by initial design, communications systems, or electronic controls becomes justified.

We are building, as a nation, a system of free highways, but we as engineers should examine carefully the experience of our turnpike authorities. A comparison between the operation of a toll facility as compared to a free facility is interesting. Under a toll authority you will find a direct line of authority and responsibility to include all elements of the highway as a system. The same agency finances the project, is responsible for design and construction, operates the facility with its own traffic engineering and enforcement, and maintenance staffs, provides motorists services along the way. And finally, the attractiveness of the facility is reflected in traffic volume and direct revenue in the form of tolls. The operating agency can justify or correlate any expenditure against revenue and operational savings. The economic cycle or formula of investment, operation, and revenue is complete and vested in a single agency.

But consider the complexity of a free facility with the divided responsibilities for planning, design, construction, enforcement, maintenance, and traffic operations. Further, savings in the refinement of operation through a reduction in delay or an improvement in safety accrue to the motoring public and are frequently lost sight of in the deliberations of the political agency responsible for operation. Further the important problem of motorist services, gas and oil, mechanical repair, lodging, meals, rest areas, fire, and medical aids, are left to the obvious economic attraction to free enterprise.

While we can be sure that free enterprise will take full advantage of the opportunity it is not at all sure, at this time, that the needs of motorists will be met in a manner that will provide maximum operating efficiency.

Political agencies will do well to organize their highway administrative structure so that the integrated and coordinated system operation achieved by the turnpike authorities may be duplicated in so far as possible.

In a nation whose economy revolves around automotive transportation we are entering a new era of highway operations. We dare not underestimate the importance of the efficient operations of the rapidly developing interstate system of highways. All engineering agencies must adopt the concept that the term interstate system does not just refer to the ribbons of concrete and asphalt pavement but that it refers as well to the movement of persons and goods, the rolling stock, the dynamics of the facility, and its operation as an integrated transportation system. Without such a concept it is doubtful that the full potential of the Interstate System of National and Defense Highways can be achieved.

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CORRELATION OF GEOMETRIC DESIGN DIRECTIONAL SIGNING[a]

Closure by G. M. Webb

G. M. WEBB,[1] A. M. ASCE.—The discussion by Steven G. Petersen brings up the matter of signing destinations at the gore and suggests that this last-minute information might produce unsafe lane changes.

From the time that multi-lane divided highways were first constructed in California, lane assignment signs were used to direct traffic to the proper lane well in advance of the turnoff. Such signs which indicate the destination and the words "USE RIGHT LANE" or "USE LEFT LANE", as the case might be, were placed as a dual installation outside the right shoulder and in the median at a distance of 1/4 mile to 1 mile in advance of the turnoff as conditions dictated. On the heavier volume freeways, particularly in the urban areas, lane assignment is now handled by overhead signs well in advance of the turnoff with a downward point arrow directly over the proper lane. We have found such lane assignment absolutely essential on the high traffic freeways where the volume of traffic generally precludes the possibility of last-minute lane changes.

As a result of advance lane assignment, California accident records show that turns to an off-ramp from the wrong lane are virtually non-existent as an accident causative factor. A sort of the 3820 accidents which occurred on California's rural freeways during 1956 and 1957 showed a two-year total of only 21 accidents which involve such improper turn at an off-ramp.

California began placing destinations in the gore about 5 years ago. Prior to that time, the last directional sign had been placed at the start of the deceleration lane. However, observance indicated uncertainty, hesitation and occasional stoppages due to the lack of reassurance at the gore. Recently, reflectorized borders have been added on reflectorized directional signs primarily to facilitate locating the gore sign during periods of darkness.

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a. Proc. Paper 1627, May, 1958, by G. M. Webb.

1. Asst. Traffic Engr., California Div. of Highways, Sacramento, Calif.

REINFORCEMENT IN CONTINUOUS CONCRETE PAVEMENTS[a]

Discussion by Bengt F. Friberg

BENGT F. FRIBERG,[1] M. ASCE.—Engineers with an interest in concrete pavements, and striving to understand their structural behaviour, are indebted to the author for his contribution. Continuously reinforced pavements need to be discussed both to dispel erroneous postulates concerning their design and to understand observed performance of experimental installations. The author's presentation of design thoughts is of value in stimulating thinking and discussion of the subject. If continuous pavements (pavements without freely opening and closing joints) could be economized, they may well become advantageous.

The author has presented computational data, firstly, on desirable maximum distance between cracks to assure effective aggregate interlock and coaction of the individual components between cracks, secondly, on stresses in and amount of continuous steel to assure steel strength at cracks greater than the concrete strength in bonded sections away from cracks. The data pertain to fully restrained pavement lengths and are based on the supposition that contracting and/or shrinking pavements, which cannot undergo length change by reason of continuous bonded steel across cracks, crack further by reason of evenly distributed concrete tension stresses if components are substantially longer than the desirable maximum length (say twice as long). As the tension in the steel at the crack is transferred to the concrete on each side by bond, the necessary bonding area in relation to average (evenly distributed) bond stress of the steel has been suggested. The numerical example of application of the computations is based on physical constants which are conventionally recognized as representative, except as regards shrinkage in concrete pavements and bond values in relation to the steel stress.

The author introduces the design variable of shrinkage; in the numerical example .02% is given as a quantitative value. It is doubtful that shrinkage is a phenomenon of consequence in pavements, except of much lower amount for a short period at early age. There is more evidence in concrete pavements on subgrades of progressive expansion, and of seasonal length change opposite in direction to the seasonal temperature length change and lessening it by the equivalent of 15 to 25 F. (Ref. 6 p. 26). However, taking both shrinkage e_s and temperature drop T into account, the desirable maximum distance L between cracks in order that the desirable crack width may not be exceeded, would be given by Eq. (2). (Any indication from Fig. 1 that a crack spacing

a. Proc. Paper 1799, October, 1958, by Vedat A. Yerlici.

1. Cons. Engr., St. Louis, Mo.

Ref. 6: Teller, L. W., and Sutherland, E. C.—The Structural Design of Concrete Pavements. Public Roads Vol. 16, No. 9, November 1935.

could approach 2L appears to be misleading, Eq. (1) being written for a crack spacing L). Applying Eq. (2) to the numerical example, for 0.02 in. maximum crack width, would give:

$$L = \frac{0.02 - 0.00067}{0.0002 + 0.00048 - 0.000067} = 31.5",$$

(The last terms in the numerator and denominator represent the concrete strains and could be omitted without great significance, in which case L = 29.5 in.)

Almost all experimental continuously reinforced pavements built to date have exhibited much greater crack spacing, from 60 to 100 in. (Ref. 3, p. 180), and more at early age. Considering an average crack spacing of 80 in., no shrinkage, and 60 F. temperature drop, the actual average crack width at low temperature according to Eq. (3) would be about

$$80 \times 0.000006 \times 60 = 0.029 \text{ in.}$$

Considering that crack spacing during the first winter may be over 10 ft. some cracks may be much wider than others. It is doubtful, therefore, that design of continuously reinforced pavements can assume crack widths as low as 0.02 in. Whether or not aggregate interlock is effective across wider cracks in continuous pavements has not been investigated on the experimental projects in existence.

Bond Determines Steel Stress

A fundamental question concerning accuracy of the proposed design computations is the computational disregard of relationships between steel stress at crack and bond slip. Fig. 5, ref. 3 shows observed slip in single-pull bond tests recorded in the literature. (It could be expected that the steel stress corresponding to a recurrent maximum crack width would decrease with repeated movements.) It is doubtful that steel stresses higher than 40,000 to 50,000 psi. could be expected in #5 bars at .02 to .03 in. crack widths. (On the Illinois experimental project in #4 bars a steel stress of 62,000 psi. was observed at about 70 F. temperature drop—Ref. 3, p. 181, Fig. 15—, when the crack spacing averaged 120 in. and the average crack width would have been at least .03 in.). Steel stress, as high as the 70,000 psi. applied by the author in his numerical example could be anticipated at low temperature only for crack spacing several fold longer than that intended. Bond slip of the steel at the cracks would result in much lower stress for close crack spacing.

The theoretical relationships have been developed in Ref. 3, Eq. (14) of which gives steel stress at the crack for any bond distribution. If, as assumed by the author, an average bond is considered active for each half of component length, "c" and "b" would each equal a/2 of Eq. (14), which would then take the form (using Yerlici's nomenclature):

$$f_s = E_s \alpha T \left(1 + \frac{1}{1 + 2\eta p}\right) \qquad (12)$$

If the bond were evenly distributed along the bar, which might be an acceptable assumption for small crack spacing, and excluding stress due to shrinkage,

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Ref. 3: Friberg, B. F.—Frictional Resistance under Concrete Pavements and Restraint Stresses in Long Reinforced Slabs, Proc. H.R.B. Vol. 33, 1954 p. 167.

the steel stress at cracks would accordingly always be less than twice that for restraint in the steel alone; for the temperature drop assumed in the example, twice 14,400 psi., or about 28,000 psi. To approach the desirable crack spacing with continuous steel reinforcement would accordingly necessitate much lower design steel stress than indicated in the example. The lower limit of steel stress, $E_s \cdot \alpha T_1$ could occur if there were no bond and the continuous steel instead anchored at one point in each component.

Actually, the bond concentration near cracks, and the bond slip at the crack are important considerations governing steel stress. High steel stresses and wide cracks may occur during the first cold season when cracks are spaced far apart. Continued cracking is the result of flexural stresses in combination with tension stresses, not tension stresses alone, for crack spacings observed on experimental projects. At later age and smaller crack spacing steel stresses at cracks would be very much lower. Only for very high steel percentages and correspondingly low stresses could the author's design criteria, applicable to very short components, be approached with conventional steels.

Tension Stresses in the Concrete and Steel

For computation of stresses in cracked slabs it is necessary to know how the steel tension at cracks is transferred to the concrete. The procedure is outlined in Ref. 3 for temperature restraints. The steps and equations are given below for shrinkage as well as temperature restraint, using Yerlici's nomenclature. It is convenient to define a distance C/2 from the crack to the center of effective bond on each side, the stresses can then be considered constant over length C, for steel stress f_s at crack, and over L-C, concrete stress f_c and steel stress f_b in bond.

The total stresses can be most simply considered as the sum of incremental stresses:

(a) Stress distribution between concrete and bonded steel, due to shrinkage e_s alone, compression in the bonded steel $-e_s E_s/(1 + np)$, and tension f_{cb} in the concrete $+ e_s \cdot E_s \cdot p/(1 + np)$ with a shortening $e_s(L-C)/(1 + np)$ of the bonded section only.

(b) Restraint of the shrinkage by tension stresses in the steel in the unbonded length at crack f_{ss}, and in the bonded portion, concrete stress f_{cs} and steel stress $n \cdot f_{cs}$, to counteract the shortening in par. (a): $e_s (L-C)/(1 + np)$.

(c) Restraint of temperature contraction $\alpha \cdot T \cdot L$ by tension stresses in the steel at crack f_{sT}, and in the bonded portion, concrete stress f_{cT} and steel stress $n f_{cT}$.

The stresses due to shrinkage alone (a) are derived simply from the condition that steel compression must equal concrete tension, and the total strain of steel in compression plus concrete in tension must equal the shrinkage e_s. This is expressed in Eq. (4), but the concrete tension due to shrinkage alone cannot be taken equal to its tension strength, as it is directly related to the steel stress.

The shrinkage restraint stresses (b) in concrete and steel are obtained from the following equations expressing equilibrium and immobility, respectively:

$$\left.\begin{aligned} f_{ss}\,p &= f_{cs} + n f_{cs} p \;; \\ \frac{f_{ss}}{E_s} C + \frac{n f_{cs}}{E_s}(L-C) &= e_s \frac{L-C}{1+np} \end{aligned}\right\};$$

from which:

$$f_{ss} = E_s e_s \frac{L-C}{C+npL} \;;$$

$$f_{cs} = E_s \cdot e_s p \frac{L-C}{(1+np)(C+npL)} \;.$$

The equations for temperature contraction restraint (c) take the form:

$$\left.\begin{aligned} f_{sT}\,p &= f_{cT} + n f_{cT} p \\ \frac{f_{sT}\,C}{E_s} + \frac{n f_{cT}}{E_s}(L-C) &= \alpha T L \end{aligned}\right\}$$

from which:

$$f_{sT} = E_s \alpha T L \frac{1+np}{C+npL} \;;$$

$$f_{cT} = E_s p \alpha T L \frac{1}{C+npL} \;.$$

From the above increments the total stresses are obtained

$$f_s = f_{ss} + f_{sT} = E_s e_s \frac{L-C}{C+npL} + E_s \alpha T L \frac{1+np}{C+npL} \;;$$

$$f_c = f_{cb} + f_{cs} + f_{cT} = E_s e_s \frac{p}{1+np} + E_s e_s p \frac{L-C}{(1+np)(C+npL)} + E_s p \alpha T L \frac{1}{C+npL} \;;$$

from which:

$$f_s = \frac{E_s}{C+npL}\left\{e_s(L-C) + \alpha T L(1+np)\right\} \;; \qquad (13)$$

$$f_c = \frac{E_s p L}{C+npL}\,(e_s + \alpha T) \;. \qquad (14)$$

It is of interest to see that shrinkage can be considered equivalent to a temperature change, Eq. (14), for concrete stress, and, with adjustment for bond distribution, also for steel stress at the crack, Eq. (13). If, as done by the author, and neglecting his erroneous Eq. (4), the percentage p is determined for <u>total</u> concrete stress equal to its tensile strength, Eq. (14) gives:

$$p = f'_c \cdot \frac{C}{L} \cdot \frac{1}{E_s e_s + E_s \alpha T - n f'_c} \cdot \qquad (15)$$

Eq. (15) can be applied to the numerical example with bond evenly distributed between the ends and the mid-point (C = L/2), we obtain:

$$p = 400/2\ (6{,}000 + 180 \cdot 80 - 10 \cdot 400) = .0122$$

The required steel is accordingly 1.22%. If that value of p is inserted in Eq. (13) the corresponding steel stress is found to be 30,800 psi., for shrinkage as well as temperature restraint.

It should be noted that evenly distributed bond is an unrealistic assumption except for short crack spacing, and that for lower steel percentage, bond would be concentrated near the ends of longer components.

CONCLUSIONS

Economy of continuously reinforced pavements is dependent upon the use of much less steel than the 1.2% found to be necessary to propagate cracking with tension stresses alone. Even if it were feasible to induce cracks at sufficiently close spacing to assure aggregate interlock (crack width 0.02 in.), the short length of the individual components would weaken the pavement in transverse direction. Satisfactory longitudinal interaction must be sought in means which would be effective for crack spacing nearer to 10 ft. at mature age.

PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Pipeline (PL), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways and Harbors (WW), divisions. Papers sponsored by the Department of Conditions of Practice are identified by the symbols (PP). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper number are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 1859 is identified as 1859 (HY 7) which indicates that the paper is contained in the seventh issue of the Journal of the Hydraulics Division during 1958.

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APRIL: 1580(EM2), 1581(EM2), 1582(HY2), 1583(HY2), 1584(HY2), 1585(HY2), 1586(HY2), 1587(HY2), 1588 (HY2), 1589(IR2), 1590(IR2), 1591(IR2), 1592(SA2), 1593(SU1), 1594(SU1), 1595(SU1), 1596(EM2), 1597(PO2), 1598(PO2), 1599(PO2), 1600(PO2), 1601(PO2), 1602(PO2), 1603(HY2), 1604(EM2), 1605(SU1)[c], 1606(SA2), 1607(SA2), 1608(SA2), 1609(SA2), 1610(SA2), 1611(SA2), 1612(SA2), 1613(SA2), 1614(SA2)[c], 1615(IR2)[c], 1616 (HY2)[c], 1617(SU1), 1618(PO2)[c], 1619(EM2)[c], 1620(CP1).

MAY: 1621(HW2), 1622(HW2), 1623(HW2), 1624(HW2), 1625(HW2), 1626(HW2), 1627(HW2), 1628(HW2), 1629 (ST3), 1630(ST3), 1631(ST3), 1632(ST3), 1633(ST3), 1634(ST3), 1635(ST3), 1636(ST3), 1637(ST3), 1638(ST3), 1639(WW3), 1640(WW3), 1641(WW3), 1642(WW3), 1643(WW3), 1644(WW3), 1645(SM2), 1646(SM2), 1647 (SM2), 1648(SM2), 1649(SM2), 1650(SM2), 1651(HW2), 1652(HW2)[c], 1653(WW3)[c], 1654(SM2), 1655(SM2), 1656(ST3)[c], 1657(SM2)[c].

JUNE: 1658(AT1), 1659(AT1), 1660(HY3), 1661(HY3), 1662(HY3), 1663(HY3), 1664(HY3), 1665(SA3), 1666 (PL2), 1667(PL2), 1668(PL2), 1669(AT1), 1670(PO3), 1671(PO3), 1672(PO3), 1673(PL2), 1674(PL2), 1675 (PO3), 1676(PO3), 1677(SA3), 1678(SA3), 1679(SA3), 1680(SA3), 1681(SA3), 1682(SA3), 1683(PO3), 1684 (HY3), 1685(SA3), 1686(SA3), 1687(PO3), 1688(SA3)[c], 1689(PO3)[c], 1690(HY3)[c], 1691(PL2)[c].

JULY: 1692(EM3), 1693(EM3), 1694(ST4), 1695(ST4), 1696(ST4), 1697(SU2), 1698(SU2), 1699(SU2), 1700(SU2), 1701(SA4), 1702(SA4), 1703(SA4), 1704(SA4), 1705(SA4), 1706(EM3), 1707(ST4), 1708(ST4), 1709(ST4), 1710 (ST4), 1711(ST4), 1712(ST4), 1713(SU2), 1714(SA4), 1715(SA4), 1716(SU2), 1717(SA4), 1718(EM3), 1719 (EM3), 1720(SU2), 1721(ST4)[c], 1722(ST4), 1723(ST4), 1724(EM3)[c].

AUGUST: 1725(HY4), 1726(HY4), 1727(SM3), 1728(SM3), 1729(SM3), 1730(SM3), 1731(SM3), 1732(SM3), 1733 (PO4), 1734(PO4), 1735(PO4), 1736(PO4), 1737(PO4), 1738(PO4), 1739(PO4), 1740(PO4), 1741(PO4), 1742 (PO4), 1743(PO4), 1744(PO4), 1745(PO4), 1746(PO4), 1747(PO4), 1748(PO4), 1749(PO4).

SEPTEMBER: 1750(IR3), 1751(IR3), 1752(IR3), 1753(IR3), 1754(IR3), 1755(ST5), 1756(ST5), 1757(ST5), 1758(ST5), 1759(ST5), 1760(ST5), 1761(ST5), 1762(ST5), 1763(ST5), 1764(ST5), 1765(WW4), 1766(WW4), 1767(WW4), 1768(WW4), 1769(WW4), 1770(WW4), 1771(WW4), 1772(WW4), 1773(WW4), 1774(IR3), 1775 (IR3), 1776(SA5), 1777(SA5), 1778(SA5), 1779(SA5), 1780(SA5), 1781(WW4), 1782(SA5), 1783(SA5), 1784 (IR3)[c], 1785(WW4)[c], 1786(SA5)[c], 1787(ST5)[c], 1788(IR3), 1789(WW4).

OCTOBER: 1790(EM4), 1791(EM4), 1792(EM4), 1793(EM4), 1794(EM4), 1795(HW3), 1796(HW3), 1797(HW3), 1798(HW3), 1799(HW3), 1800(HW3), 1801(HW3), 1802(HW3), 1803(HW3), 1804(HW3), 1805(HW3), 1806 (HY5), 1807(HY5), 1808(HY5), 1809(HY5), 1810(HY5), 1811(HY5), 1812(SM4), 1813(SM4), 1814(ST6), 1815 (ST6), 1816(ST6), 1817(ST6), 1818(ST6), 1819(ST6), 1820(ST6), 1821(ST6), 1822(EM4), 1823(PO5), 1824 (SM4), 1825(SM4), 1826(SM4), 1827(ST6)[c], 1828(SM4)[c], 1829(HW3)[c], 1830(PO5)[c], 1831(EM4)[c], 1832(HY5)[c]

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DECEMBER: 1859(HY7), 1860(IR4), 1861(IR4), 1862(IR4), 1863(SM5), 1864(SM5), 1865(ST8), 1866(ST8), 1867 (ST8), 1868(PP1), 1869(PP1), 1870(PP1), 1871(PP1), 1872(PP1), 1873(WW5), 1874(WW5), 1875(WW5), 1876 (WW5), 1877(CP2), 1878(ST8), 1879(ST8), 1880(HY7)[c], 1881(SM5)[c], 1882(ST8)[c], 1883(PP1)[c], 1884(WW5)[c], 1885(CP2)[c], 1886(PO6), 1887(PO6), 1888(PO6), 1889(PO6), 1890(HY7), 1891(PP1).

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JANUARY: 1892(AT1), 1893(AT1), 1894(EM1), 1895(EM1), 1896(EM1), 1897(EM1), 1898(EM1), 1899(HW1), 1900(HW1), 1901(HY1), 1902(HY1), 1903(HY1), 1904(HY1), 1905(PL1), 1906(PL1), 1907(PL1), 1908(PL1), 1909(ST1), 1910(ST1), 1911(ST1), 1912(ST1), 1913(ST1), 1914(ST1), 1915(ST1), 1916(AT1)[c], 1917(EM1)[c], 1918(HW1)[c], 1919(HY1)[c], 1920(PL1)[c], 1921(SA1)[c], 1922(ST1)[c], 1923(EM1), 1924(HW1), 1925(HW1), 1926 (PL1), 1927(HW1), 1928(HW1), 1929(SA1), 1930(SA1), 1931(SA1), 1932(SA1).

FEBRUARY: 1933(HY2), 1934(HY2), 1935(HY2), 1936(SM1), 1937(SM1), 1938(ST2), 1939(ST2), 1940(ST2), 1941(ST2), 1942(ST2), 1943(ST2), 1944(ST2), 1945(HY2), 1946(PO1), 1947(PO1), 1948(PO1), 1949(PO1), 1950(HY2)[c], 1951(SM1)[c], 1952(ST2)[c], 1953(PO1)[c], 1954(CO1), 1955(CO1), 1956(CO1), 1957(CO1), 1958 (CO1), 1959(CO1).

MARCH: 1960(HY3), 1961(HY3), 1962(HY3), 1963(IR1), 1964(IR1), 1965(IR1), 1966(IR1), 1967(SA2), 1968 (SA2), 1969(ST3), 1970(ST3), 1971(ST3), 1972(ST3), 1973(ST3), 1974(ST3), 1975(ST3), 1976(WW1), 1977 (WW1), 1978(WW1), 1979(WW1), 1980(WW1), 1981(WW1), 1982(WW1), 1983(WW1), 1984(SA2), 1985(SA2)[c], 1986(IR1)[c], 1987(WW1)[c], 1988(ST3)[c], 1989(HY3)[c].

APRIL: 1990(EM2), 1991(EM2), 1992(EM2), 1993(HW2), 1994(HY4), 1995(HY4), 1996(HY4), 1997(HY4), 1998 (SM2), 1999(SM2), 2000(SM2), 2001(SM2), 2002(ST4), 2003(ST4), 2004(ST4), 2005(ST4), 2006(PO2), 2007 (HW2)[c], 2008(EM2)[c], 2009(ST4)[c], 2010(SM2)[c], 2011(SM2)[c], 2012(HY4)[c], 2013(PO2)[c].

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c. Discussion of several papers, grouped by divisions.

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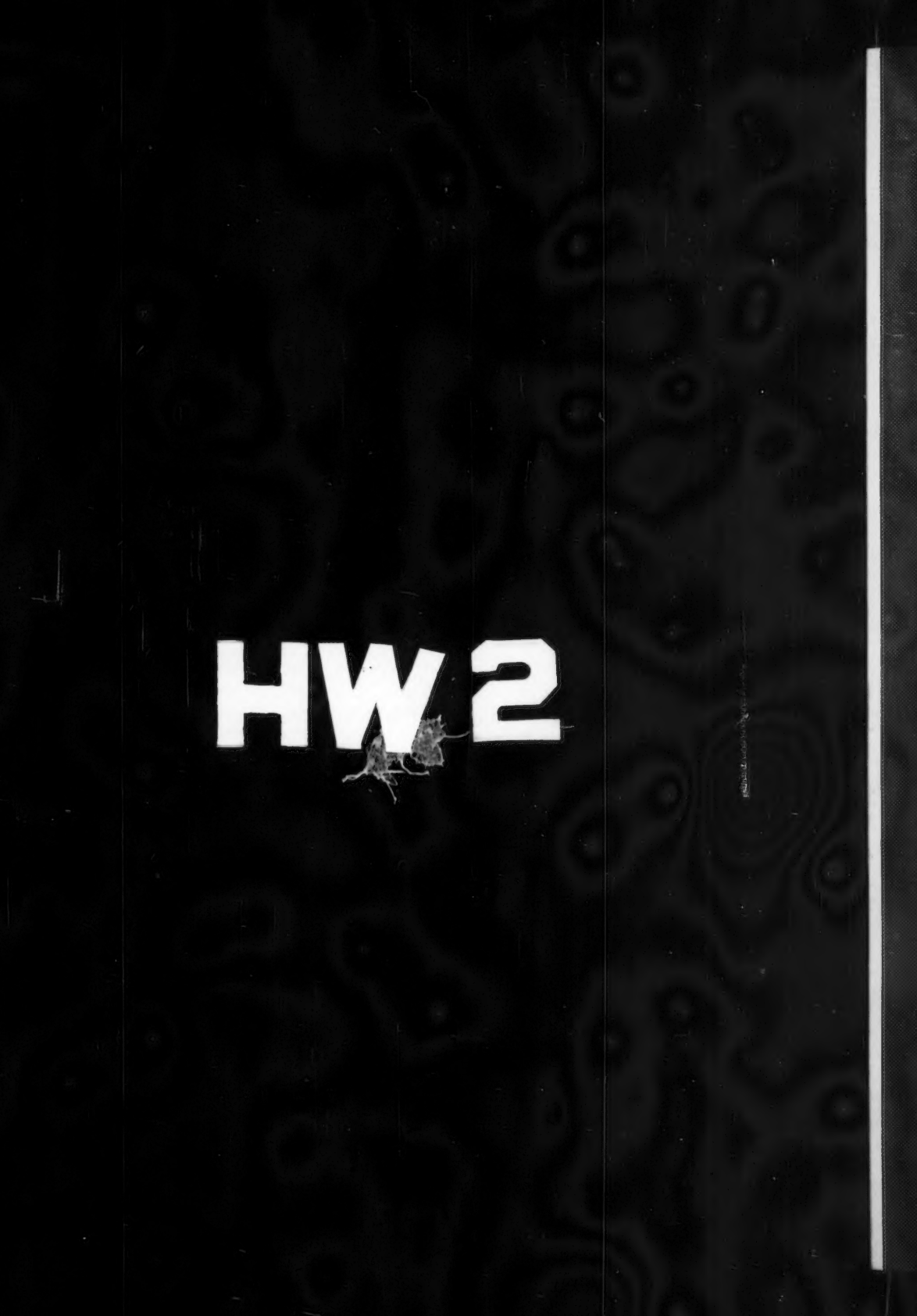
HW2

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Your attention is invited

NEWS OF THE HIGHWAY DIVISION OF ASCE

JOURNAL OF THE HIGHWAY DIVISION
PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

DIVISION ACTIVITIES
HIGHWAY DIVISION
Proceedings of the American Society of Civil Engineers

NEWS

April, 1959

PROGRESS AND THE HIGHWAY ENGINEER
(An Editorial)

This is a dynamic age. There is nothing static about it. In the long recorded history of the life of the human being, there has been nothing to equal the advances being made from day to day in the technological and social sciences.

Each day brings new machines designed to do something faster, better and at less cost.

And each day brings new facts about our society and how we can control the forces making for social and economic betterment.

Highway administrators, because of the tremendous importance of vehicle transportation, must be aware of these technical innovations and these new social and economic tools. They must be adept enough to bring these new tools into actual use in day to day highway affairs.

In the field of highway design, planning and engineering, the highway departments must make certain they don't lag behind in the general march of progress. It would be an intolerable situation if the highway administrator were to sit idly by, watching the rapid strides being made in other fields of human endeavor without taking action to move his organization along in this continuing attempt to do more with less effort and at less cost.

Traditional ways of doing things certainly have an importance. But, only as a measure of the new, for very often the highway administrator uses these traditional ways as an excuse for inaction. He rationalizes present practices by saying that they have worked in the past—why shouldn't they now?

We should recognize this—that the test of whether something is being done wrong now is whether it was being done in the past. If it was good enough for father, it simply isn't good enough for us.

Electronic machines, aerial photographs and optical aids have been introduced into highway engineering over the past few years. All have demonstrated undoubted usefulness in helping make locations, in computing earthwork volumes and in many other ways they have helped the engineer do a better job.

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But it isn't only in this field of machines that we find advances being made in getting more done with less effort.

For new personnel practices and policies are being developed which encourage the able and the ardent and the ambitious to assume posts of major importance--to assume the job of getting the work done with a minimum of effort.

Then in the field of public relations, new techniques are being developed and new results are being realized. It may be that in the past a good public relations program was not a necessary part of the highway department's program. But that day is gone forever. Highways occupy such a vital segment of our daily life and the highway department's program has come to play such an important part in the life of every citizen, that a consciously directed and skillfully executed public relations program is a must for the highway administrator. He can't shrug it off. It's his responsibility to see that the public relations are good. If the public relations are bad, he's the fellow to blame.

We could go on into this detailing of new machines and new social techniques ad infinitum, but the point is this--the highway administrator must realize the dynamism of the age we're living in. He must stay abreast of the times. He must not rationalize present methods by averring that they were sufficient for years past.

The highway administrator must keep his organization a part of this dynamic society--alert to discover new and better ways of doing things--alert to the changes in engineering and social techniques every day brings.

So much of our nation's progress over the next several decades depends upon building efficient motor vehicle services that highway administrators must act in the best traditions of the public service.

To do less would be unthinkable.

To do more is expected.

To make progress is required!

William A. Bugge
Member, Executive Committee
Director of Highways
Washington State Highway Commission

* * *

COMMENT ON NEWSLETTER EDITORIAL

John O. Morton, Commissioner of Public Works and Highways of the State of New Hampshire, made the following statement concerning the first Newsletter editorial, written by Arch N. Carter:

> "I feel that Arch has performed a fine job in developing this editorial. Being directly connected with the highway program, I strongly endorse access control and can say that if highway engineers will look forward they can realize untold benefits from this type of long range planning."

COMMITTEE NEWS

Executive Committee Meeting of October 16, 1958

Resolutions of Appreciation

"Resolution of thanks to Carl E. Fritts of the Automotive Safety Foundation and his ASCE Committee on Highway Engineering Manpower for preparation of the brochure, A Career For You In Highway Engineering."

"Resolution of thanks and appreciation to the Automotive Safety Foundation for its assistance on preparation of the brochure, A Career For You In Highway Engineering."

This brochure was described in the January 1958 issue of this Newsletter.

In its resolutions, the Executive Committee commended the Committee on Highway Engineering Manpower for having produced "a very well-written brochure . . . of which both the committee and the Society's Highway Division can be proud."

The Executive Committee congratulated Mr. Fritts and his committee for the "splendid response by the highway engineering profession to the new publication."

The committee commended the Automotive Safety Foundation for its "invaluable assistance on preparation of the ASCE brochure" and its aid on distribution of the booklet. Indicating the wide acceptance of the brochure by the State Highway Departments and similar groups, the Executive Committee extended "to the Automotive Safety Foundation the committee's heartfelt thanks for the Foundation's extensive assistance on preparation of the brochure . . ." and for its "great and timely aid in distributing the new publication."

The Executive Committee adopted a resolution expressing appreciation for the helpful services and advice of R. Robinson Rowe as Board Contact Member for the past several years and expressed regret that his term of office had been completed.

Proposed Drainage Structures Committee

Mr. Rowe discussed the need for a new technical Committee on Highway Drainage Structures, the purpose of the committee to be as follows:

> "To study the design and performance of highway drainage structures generally and underground facilities particularly, combining economically the principles of hydraulics, structures and soil mechanics applicable thereto; to cooperate with committes of allied purpose within other technical divisions in the development of criteria for coordinated designs."

It was decided that Society headquarters be requested to approve such a committee.

Proposed Committee on Pipeline Crossings

Mr. Rowe discussed the need for a new technical Committee on Pipeline Crossings, the purpose of the committee to be as follows:

> "To study from the highway viewpoint the problems of location, de-

sign, construction, maintenance, repair, replacement and relocation of pipelines (other than highway facilities) crossing under or over highways; to cooperate with committees of like purpose within other technical divisions in the development of policy, specifications, standards or manuals of practice for such crossings."

It was decided that Society headquarters be requested to approve this committee also.

National Transportation Policy

Mr. Kennedy and Mr. Rowe discussed the need for a special task committee to study and report on the status, direction and future impact of the emerging national transportation policy.

The Executive Committee agreed as to the desirability for such a special task committee and requested Mr. H. E. Davis and Mr. Norman Kennedy to write the mission and justification for such a committee.

Discussion by Dean Harold B. Gotaas on Society Research Plans. Dean Gotaas discussed the research problems and Society research plans and stressed particularly the need for more basic research.

Future Sessions Program Chairmen

The Secretary will seek suggestions from the Louisiana State Department of Highways for a Highway Division Sessions Program chairman for the New Orleans meeting in March, 1960. Mr. Louis Duclos, Assistant Bridge Engineer of the Louisiana Department of Highways, has been appointed.

The committee approved Mr. George Langsner, Design Engineer, Department of Public Works, California Division of Highways, as chairman for the Reno meeting, June, 1960.

Mr. Morton will recommend a chairman for the Boston meeting in October, 1960.

Report of the Committee on Urban Transportation

Mr. Norman Kennedy, Chairman of the Committee on Urban Transportation, reported on the meeting of his committee held on Monday, October 13.

During the year, the committee held two business meetings, one in New York, October, 1957, and one in Chicago, February, 1958, and sponsored a half-day session at the Chicago meeting.

Mr. Kennedy stated it was the consensus of the committee that for the present, primary activity should be to sponsor Society meeting papers directed toward development and interpretation of data on urban highway transportation planning. He stated that this committee would like to take responsibility for one session at the Los Angeles meeting and one session at the Washington, D. C. meeting. The committee also sponsored a session at the Los Angeles meeting.

The Executive Committee approved the request and directed the Secretary to so advise the respective program chairmen.

Committee on Geometrics of Highway Design

Mr. D. C. Greer, State Highway Engineer of Texas, has agreed to serve on the committee.

New York Meeting

Mr. George H. Leland reported on the Highway Division and Joint Sessions during the New York meeting. Attendance was excellent, ranging from 70-115.

The Executive Committee commended Mr. Leland for his excellent planning of the program.

Resolution of Appreciation to Retiring Committee Members

The following resolution was adopted:

"The Executive Committee of the Highway Division expresses its appreciation to the following members of the Highway Division Committees who have completed their terms of membership on these committees, as well as to those who have found that the pressures of other work necessitated their resignation:

H. E. Davis, Lowell E. Gregg, Robert E. Williford, J. E. Leisch, G. S. Paxson, George H. Leland, James J. Mennis, Bonner Coffman, Ralph L. Fisher, J. C. Young, C. E. Fritts, D. H. Bray, H. G. Sours, Robley Winfrey (Committee on Highway Engineering Manpower), John Clarkeson, F. M. Davis, A. F. Malo, H. A. Mike Flanakin, John A. Logan.

We wish to extend our thanks for your cooperation and it is our hope that you feel your activity was productive for you, as well as for the Highway Division."

Committee on Cooperation with Local Sections

In an effort to improve the enlistment of active support of the Local Sections, and to bring them actively into the national activities, Mr. S. E. Ridge, Chairman, is contacting the chairmen of similar committees of the other ASCE divisions with a view to obtaining their cooperation. The intent would be a concerted effort to have the Local Section appoint contact members with each of the interested divisions.

JUST OFF THE PRESS

PAPERS FROM THE CONFERENCE ON ELECTRONIC COMPUTATION

In response to the unprecedented demand expressed by the Conference participants, the twenty-five papers presented at the Conference on Electronic Computation held in Kansas City, Missouri on November 20-21, 1958 are being offered in a single paper-bound volume. This special edition is composed of the twenty-two technical papers and the welcome address, the keynote address, and the luncheon address, all as delivered at the Conference. The prices (post-paid) are as follows:

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ENDORSEMENT OF AASHO POLICY STATEMENT

The Executive Committee of the Highway Division has unanimously endorsed the policy statement of the American Association of State Highway Officials, adopted in San Francisco, November 30, 1958 and urges all civil engineers to support the policy.

The statement of policy is as follows:

The administration and construction of the federal-aid highway programs should continue to be the historic responsibility of the State highway department-Federal Bureau of Public Roads partnership that has proven to be so effective and in the public interest.

Adequate financing for the current enlarged federal-aid highway program should be provided so that the expressed intent of Congress to continue the ABC federal-aid highway program and to construct the National System of Interstate and Defense highways within the prescribed time will have meaning and will give support to the assurances of an accelerated and continuing program by the Congress, that was the basis for the highway departments and the highway industry organizing and enlarging to handle the program.

The State highway departments endorse the Interstate program time schedule as provided in the Act of 1956 and reassures the Congress of their ability to efficiently construct the program on the basis of that schedule as well as warning of the economic impact of a drastic cutback or drawout in the program.

Upon completion of a Federal Aid Highway Project, and in conformance with long established practice, the State should have sole responsibility, at State expense, of maintaining, policing and operating the facility.

The matter of developing highway design standards and highway signing and traffic control methods for the federal-aid highway systems is engineering and technical in nature and should not be established by Federal legislation, but handled jointly by the State highway departments and the Bureau of Public Roads.

It is of the utmost importance that the construction program be kept in balance for the various federal-aid systems involved. Authorizations for Primary and Secondary Systems and Urban extensions should provide annual incremental increases for each category and in an amount that the Congress deems justifiable in view of the need and of the total federal funds available for highway purposes.

The Association agrees with the provisions of Section 102(a) of the Highway Act of 1956 as they relate to the percentage distribution of funds to the Primary and Secondary Systems and Urban extensions and as to the transfer provisions provided between these systems as set forth in Section 102(c), as well as the established matching ratios and participation by the States.

The Association endorses the Interstate System design standards as developed and adopted by the State highway departments and as approved by the Secretary of Commerce on July 17, 1956 in accordance with law. The control of access concept, as provided in the standards, is of the utmost importance in protecting the large investment being made in the Interstate System and in realizing the maximum efficiency, comfort and safety for the public in that system.

The Association endorses periodic Interstate System estimates as an equitable and proper basis for the apportioning of federal funds to the several States to achieve simultaneous construction and completion of the Interstate System in all States to adequate standards.

Apportionments in the full amounts of the Congressional authorizations for all federal domain roads should be made and utilized, and such funds should not come from the Highway Trust Fund.

The Association vigorously opposes the use of any Trust Fund monies for any purposes other than to pay the cost of operating the Bureau of Public Roads and for building highways.

Adding mileage to the Interstate System at this time would result in the delay of the completion of transcontinental routes and would extend the program over a longer period of time.

There should be no extension of Section 115 of the Highway Act of 1956 whereby the Federal determination of wage rates would be extended to projects on other road systems nor should there be legislation to provide additional federal control or jurisdiction over wages paid on Interstate System projects.

NEW ORLEANS CONVENTION, MARCH 1960

Mr. Louis Duclos, Assistant Bridge Design Engineer, State Department of Highways, Baton Rouge, Louisiana, will serve as Chairman of the Highway Division Sessions Programs and as a member of the Session Programs Committee for the ASCE meeting in New Orleans, March 8-12, 1960.

MEETING CALENDAR

ASCE Meetings - 1959

May 4-8 — Cleveland Convention

Contact: Alfred D. Yanda
Hargett, Yanda & Barber
4500 Euclid Avenue
Cleveland, 3, Ohio

October 19-23 — Washington Convention

Contact: Carl E. Fritts
Automotive Safety Foundation
200 Ring Building
Washington 6, D. C.

1960

March 7-11 — New Orleans Convention

Contact: Louis Duclos
Assistant Bridge Design Engineer
State Department of Highways
Baton Rouge, Louisiana

June 19-23 — Reno Convention

Contact: George Langsner
Engineer of Design
Division of Highways
P. O. Box 1499
Sacramento 7, California

Non-ASCE Meetings - 1959

May 10-14 — American Society of Planning Officials
National Planning Conference

Contact: ASPO,
1313 E. 60th Street
Chicago 37, Illinois

September 14-17 — Institute of Traffic Engineers
29th Annual Meeting, New York City

Contact: ITE
2029 K Street, N. W.
Washington 6, D. C.

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